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APPENDIX E
Contract Construction

THIS segment covers new construction (including additions, alterations, and repairs as well as new projects) carried on by (1) general contractors in building construction and in highway, street, and other heavy construction; and (2) special trade contractors, specializing in activities such as plumbing, painting, plastering, and carpentering—either on subcontract from the general contractor or directly for the owner. In the Standard Industrial Classification these categories correspond to Major Groups 15, 16, and 17. Construction performed by force-account workers in establishments primarily engaged in some other business is not included.

Output

The investigator faces at least two major problems in attempting to measure the physical volume of contract construction. One relates to the fact that most buildings and heavy construction projects are not standardized over time but are custom jobs. Thus, numbers of units cannot be weighted to form time series, nor can a sample of units be priced in the ordinary sense to provide indexes for the purpose of deflating value estimates. The other problem is that the available estimates of the value of new construction put in place include more than contract construction, to which the manpower estimates relate. The activity values include also force-account work, which is particularly important in the utility and farm segments and in the category of major alteration and repair.

Our partial solutions of these problems will be discussed in the course of describing the method by which we estimate the real product originating in the construction segment on a basis consistent with the total real national product estimates. These estimates do not purport to be of the same degree of reliability as those made for the segments for which reasonably good physical-unit or price series were available. They are the result of making explicit the implications of the real national product estimates with respect to the portion originating in construction. The output series will be compared with employment and manhours estimates, following a description of the labor series.

SCOPE OF THE ESTIMATES

A solution to the contract versus total construction activity problem is suggested by the availability of estimates of national income originating in the contract construction industry prepared by Kuznets and by the

Department of Commerce. The former series begins with 1919; the latter, with 1929. By adding estimates of capital consumption and the contract construction share of indirect business taxes and the other reconciliation items, the national income figures can be expanded to gross national product originating in the industry. Gross national product can then be deflated to provide output estimates relating to contract construction alone.

As we have previously remarked, real gross industry product should be obtained by a "double deflation" procedure. That is, the gross value of output should be deflated by a composite index of output prices, and intermediate products, by a properly weighted index of the prices of the purchased goods and services. Direct deflation of GNP originating can be justified only if intermediate-product purchases are small relative to the value of output, or if prices of intermediate inputs closely parallel prices of output in movement. Materials account for close to half of the value of construction, but input and output prices have moved in unison since World War I, as indicated in Table E-1. We have, therefore, applied the output deflator directly to the industry product estimates for the period since 1919.

TABLE E-1

Contract Construction: Price and Cost Indexes, Key Years, 1915–57
(1929 = 100)

	Construction Costs, Commerce Composite	Wholesale Prices of Building Materials	Average Hourly Wage Rate of Building Trades
1915	53.8	56.1	40.0
1919	100.0	121.1	55.7
1929	100.0	100.0	100.0
1937	98.1	99.8	97.9
1948	200.0	209.3	175.5
1953	234.6	241.2	226.1
1957	263.5	262.8	267.8

SOURCE: *Construction Volume and Costs, 1915-1956*, May 1957, Statistical Supplement to *Construction Review*, Depts. of Labor and Commerce, pp. 54 and 58; *Union Wages and Hours: Building Trades, July 1, 1957*, BLS Bulletin 1227, p. 5.

Prior to 1919, we have extrapolated the real national product originating in contract construction by the deflated value of the new private and public construction components of the real gross national product (described in Appendix A). This procedure involves the implicit assumption that the proportion of total new construction performed by private contractors was constant over the period up to 1919—an assumption avoided by the

procedure for the later period. If the output measure prior to 1919 is to be interpreted as "net," the further assumption is involved that the ratio of intermediate input to output was relatively stable. In the construction industry, which has not been noted for rapid technological advance, particularly in the early period, the assumption seems broadly reasonable.

THE PRICE DEFLATORS

The deflator used to convert the current value estimates to physical-volume measures after 1915 is basically the Department of Commerce "composite construction cost" index for private construction, as adjusted from 1929 on by the National Income Division to reflect changing profit margins.[1] The composite is composed of price indexes for different types of construction (Tables E-1 and E-2).

Some of these indexes are so constructed that they reflect changes in the efficiency of the industry. This is accomplished either through adjustment of estimates of labor and materials costs per unit of input for presumed efficiency change or by use of contractor bids over time on standard structures or structural components. Others of these indexes are merely weighted averages of prices of relevant materials and construction wage rates and, sometimes, of certain overhead cost items. The latter "cost indexes" presumably do not reflect changes in efficiency, and insofar as efficiency has increased in the areas for which they are used, they lend a downward bias to the derived output and productivity measures.

Of the more refined types of index, mention should first be made of the residential cost index compiled by E. H. Boeckh and Associates and used by the Commerce Department for deflation of residential building. For brick and frame residences in twenty cities, prices of many types of materials and equipment are weighted by wage rates, adjusted to reflect efficiency of local labor. Despite the presumed adjustment, productivity advance has apparently not been important in residential building. This is suggested by two comparisons.

In their study of residential real estate, Grebler, Blank, and Winnick found that there was a remarkably close correspondence between the long-term movements from 1890 to 1934 of the Boeckh index, extrapolated from 1910 to 1890 by a weighted average of materials and labor costs, and a house price index developed for their study from data contained in the Commerce *Financial Survey of Urban Housing* (1937).[2] Although the price index shows more short-term variability than the cost index (presumably due to more adequate reflection of changing profit margins),

[1] *National Income Supplement, 1954, Survey of Current Business*, Dept. of Commerce.

[2] Leo Grebler, David M. Blank, and Louis Winnick, *Capital Formation in Residential Real Estate: Trends and Prospects*, Princeton University Press (for NBER), 1956, Appendix C, pp. 344–58.

the virtual identity of the long-run movements of the two series "argues strongly that the construction cost index measures with quite reasonable accuracy the secular movement of house prices."[3]

The other comparison is between the Boeckh index and the *Engineering News-Record* (ENR) building cost index, which is simply a weighted average of materials and labor costs. Although the product mix underlying the two indexes differs somewhat, the fact that the Boeckh index rises as much as the ENR building cost index between 1913 and 1957 also suggests that productivity advance has not been important in residential building (see Table E-2). There are divergences in shorter periods, notably in

TABLE E-2

Comparison of Three Building-Cost Indexes, Key Years, 1913–57
(1929 = 100)

	Average of 4 Contractor Indexes[a]	*Engineering News-Record*	Boeckh (Residential)
1913	52.1	52.4	51.9
1919	95.8	83.4	92.0
1929	100.0	100.0	100.0
1937	98.4	102.8	93.2
1948	195.3	180.5	209.6
1953	226.0	225.7	242.4
1957	262.0	266.7	263.6

[a] Average of the estimates for building structures, comparable over time, provided by the following contractors: Austin, Fruin-Colnon, Fuller, and Turner; from Miles L. Colean and Robinson Newcomb, *Stabilizing Construction: The Record and Potential,* New York, McGraw-Hill, 1952, p. 248, extended through 1957 by data published in *Engineering News-Record.*

1948–57, when the lesser rise of the Boeckh index suggests some real increases in productivity.

Absence of greater productivity advances in building construction generally, including nonresidential, is also suggested by a comparison of the ENR building cost index with an average of four contractor indexes. The latter indexes are prepared "on the basis of actual estimates for building comparable structures" and should reflect reductions in costs per unit of output as productivity rises.[4] Nevertheless, the ENR and the contractor indexes show much the same long-run trend (Table E-2). Here again, however, there is evidence of significant productivity advance since World War II, which is reflected in the over-all measure of output per manhour shown in Table E-I.

[3] *Ibid.*, p. 352.

[4] See Miles L. Colean and Robinson Newcomb, *Stabilizing Construction: The Record and Potential,* New York, McGraw-Hill, 1952, p. 71 and also Appendix Q.

Among the indexes other than the Boeckh used in the composite deflator, efficiency changes are also purportedly reflected in those prepared by the Turner Construction Company, the George A. Fuller Company, the Interstate Commerce Commission, and the Bureau of Public Roads. The last named index deserves special mention. It is designed to represent the cost of a standard mile of federal-aid and state highway construction. It is based on average bid prices, taken from contract information, for the following items: cubic yards of excavation, square yards of paving, pounds of reinforcing steel and of structural steel, and cubic yards of structural concrete. Over the entire period since its inception in 1922, the index shows substantially less increase than an average of relevant materials and labor prices, reflecting the increased efficiency that has occurred in heavy construction generally as a result of greater mechanization and improved machinery. Table E-3, based on data prepared by the Bureau of Public

TABLE E-3

Highway Construction: Output, Manhours, and Productivity, 1944–55

	Deflated Construction Expenditures		*Manhours*		*Output per Manhour*
	Millions of 1954 Dollars	Index (1948 = 100)	Number of Millions	Index (1948 = 100)	(1948 = 100)
1944	448	24.6	97.6	28.5	86.3
1945	459	25.2	94.3	27.5	91.6
1946	986	54.1	193.4	56.5	95.8
1947	1,590	87.2	305.7	89.3	97.6
1948	1,823	100.0	342.4	100.0	100.0
1949	2,062	113.1	369.2	107.8	104.9
1950	2,263	124.1	374.8	109.5	113.3
1951	2,434	133.5	370.6	108.2	123.4
1952	2,594	142.3	374.9	109.5	130.0
1953	2,908	159.5	399.8	116.8	136.6
1954	3,659	200.7	474.5	138.6	144.8
1955	3,962	217.3	488.8	142.8	152.2

SOURCE: Indexes computed from estimated real highway construction expenditures and manhours employed, presented in *Public Roads*, Bureau of Public Roads, Dept. of Commerce, February 1957, p. 152.

Roads, compares outlays for highway construction deflated by the standard-mile cost index with the corresponding manhours worked. Comparable production and manhour estimates are available only since 1944, but sharply rising movement of output per manhour in highway construction since that date apparently prevailed in earlier periods as well.

The upward productivity trend characteristic of highway construction seems to have prevailed in heavy, engineered construction generally.

This is indicated in a study by Chawner,[5] in which labor-materials cost indexes are compared with indexes for several types of heavy construction based on contractor unit bids. The significantly greater rise in the former indexes between 1915 and 1933 is indicative of important technological advance. The contrast between the Chawner findings and the similarity of movement observed between contractor and cost indexes in building construction led Grebler, Blank, and Winnick to conclude: "A reasonable inference to be drawn is that productivity has increased significantly in heavy construction but much less so in building construction. . . . It is likely that the increases in productivity in building have been concentrated largely in the construction of large buildings, and that residential construction, particularly construction of single-family houses, has shared in this rise, except possibly in the last few years."[6]

The construction cost indexes in the Commerce Department composite deflator that are not contrived so as to make allowance for productivity change are those prepared by W. W. Handy (electric and gas utilities), the Associated General Contractors, the *Engineering News-Record*, the American Appraisal Company, and the farm construction cost indexes of the Department of Agriculture. These indexes are used to deflate types of projects that accounted for around 35 per cent of total new construction activity in 1953—but probably a lesser proportion of contract construction. Assuming that productivity in the areas deflated by cost indexes rose as much as in the areas in which price indexes were used, the over-all productivity increase in the segment would have been about half again as great as that indicated by our calculations in Table E-I. This is probably an overstatement, however, since some of the cost indexes apply to building construction, in which productivity advance has been less than in the industry generally. Even with a substantial upward adjustment, productivity in the construction segment rose significantly less than in the economy as a whole (see last section of this appendix).

Employment and Manhours

The Commerce Department estimates of the average annual number of employees in contract construction from 1929 forward are based on the *Census of Construction* for 1929 and 1935, and on average monthly employment estimates derived from Social Security data for 1938 and subsequent years. Employment in 1929 of salaried workers and of all employees in establishments with an annual volume of business under $25,000 was obtained by dividing the relevant payrolls by average pay. Employment

[5] Lowell J. Chawner, "Construction Cost Indexes as Influenced by Technological Change and Other Factors," *Journal of the American Statistical Association*, September 1935, pp. 561–76.

[6] *Op. cit.*, pp. 356–57.

in 1935 was obtained by extrapolation of the 1929 estimate by the average monthly employment of establishments that reported to the censuses of both 1929 and 1935. Annual interpolations for 1929–35 and 1935–38 were made by Commerce on the basis of the deflated volume of construction activity.

The *Census of Construction* data could not be used to estimate the number of proprietors, since they cover only business establishments and not the independently self-employed. The Commerce Department therefore shifted to the *Census of Population* occupational data for 1930, 1940, and 1950. Extrapolation to 1929 and interpolation between 1930 and 1940 were made on the basis of the number of active corporations in the industry as reported annually in *Statistics of Income*, Part I (Internal Revenue Service). Interpolation for 1940–50 and extrapolation since 1950 were made on the basis of the number of operating firms, incorporated and unincorporated, as estimated by Commerce from survey data.

Prior to 1929, our estimates of persons engaged are benchmarked on the gainful-worker estimates of Daniel Carson, adjusted by the estimated ratio of employment to labor force in the economy and further adjusted in 1920 for a probable overcount by Carson of gainful workers in the construction industry.[7] It is Stanley Lebergott's opinion that while Carson's estimates for 1930, 1910, and earlier census years are relatively reliable since they are taken almost directly from reported Census results, the 1920 estimate is high. This is ascribed to the fact that Carson interpolated between his 1910 and 1930 estimates using a series dominated by the movement in numbers of carpenters, painters, builders, and plasterers. Employment in these occupations was affected by the relatively large 1910–20 gain in employment of carpenters and painters by shipbuilding and other nonconstruction industries. Lebergott adjusted for this factor by estimating employment of the affected occupational groups in the other industries on the basis of ratios to operatives. We have accepted his downward adjustment for 1920 and his annual series covering 1920–29.[8]

The number of persons who were self-employed in construction constituted a virtually constant proportion of the total in 1940, 1930, and 1910. The 1910 figure was estimated by Lebergott, from Census lithoprints, as the sum of self-employed carpenters, masons, building contractors, electricians, building painters, paper hangers, plasterers, plumbers, roofers, and structural steel workers. As a test, he used the same procedure in 1940 and obtained a total within 2 per cent of the reported number of

[7] Daniel Carson, "Changes in the Industrial Composition of Manpower since the Civil War," *Studies in Income and Wealth, Volume 11*, New York (NBER), 1949.

[8] The Lebergott estimates for this segment, 1919–29, are identical with those published in *Handbook of Labor Statistics, 1950 Edition*, BLS Bulletin 1016, p. 5, which he helped to prepare.

self-employed.[9] On the basis of this evidence, we estimated numbers of proprietors and the self-employed for years prior to 1929 by applying their 1929 ratio to employees to the estimated numbers of employees in the earlier years.

For the period prior to 1920, annual estimates of employment were derived from a regression equation based on the value of new public and private construction in constant dollars and on employment for nine years (four decennial census years from 1890 to 1920, 1929, 1935, and 1938–40). This equation gives a coefficient of correlation of +.98 between real construction and employment.

Average hours worked per week by employees in the contract construction industry as a whole are available from the Bureau of Labor Statistics for 1946 and subsequent years. Estimates of average hours worked by employees in building construction were made by the BLS back to 1934. For 1946–50, the ratio of average hours in the broader group to average hours in building was 1.019. This ratio was applied to the latter series prior to 1946 in order to adjust it to the level of the estimates with broader coverage.

Estimates of average full-time hours in the building trades are available for the entire period since 1869. Leo Wolman's published series covers the years from 1890 to 1937.[10] It can be extended forward by the BLS estimates, and back to 1869 on the basis of estimates of average full-time hours worked per day contained in the Aldrich Report.[11]

In the years since 1934 (excluding 1942–46) there has been a fairly close relation between the ratios of actual to standard hours in building construction and of employment to labor force in the construction industry, using Carson's labor-force estimates for 1930 and 1940, and the 1950 Census estimate for the industry, with linear annual interpolations. The regression equation yields a correlation coefficient of +.94. This relationship was used to derive estimates of average actual hours from the estimates of full-time hours, and the BLS series was extrapolated from 1934 to 1869 by these estimates. The product of average hours, numbers of employees, and weeks per year yielded employee manhours.

The special Census Bureau survey for May 1953 revealed a level of average hours worked per week by proprietors and unpaid family workers that was 14.5 per cent above the BLS estimate of average hours worked by

[9] Stanley Lebergott, "Estimates of Labor Force, Employment, and Unemployment, 1900–50," unpublished MS., p. 42.

[10] *Hours of Work in American Industry*, Bulletin 21, New York (NBER), 1938. It must be noted that Wolman's hours series is based on trade union scales. Since union strength increased over the period, the series probably shows too small a downtrend when used as a measure for the industry as a whole.

[11] *Wholesale Prices, Wages, and Transportation*, Report No. 1394, Senate Committee on Finance, 52d Cong., 2d sess., 1893.

employees in contract construction. To obtain manhours for this group, the employee average hours estimates were raised by the stated percentage throughout, and multiplied by the estimated numbers of proprietors and unpaid family workers. The index of total manhours is shown in Table E-I.

Output-Manhour Comparison

The output-per-manhour series presented in Table E-I should be interpreted less as an independent estimate of the course of productivity in contract construction than as an attempt to spell out the implications of the deflated gross national product estimates in this respect. The trend rate of increase in output per manhour of 0.9 per cent a year between 1889 and 1953 prevailed in the earlier period, 1889–1919, as well as in the later period, 1919–53—so at least the cruder estimates for the earlier period do not result in unreasonable productivity implications as compared with the later period. There is considerable irregularity as among the subperiods, but it will be noted that, generally, the subperiods in which output per manhour fell are those in which the physical volume of construction activity also declined. The one exception to this statement occurred in the subperiod 1889–99, but here the rate of increase in activity decelerated markedly as compared with the two earlier subperiods. Between 1937 and 1948, despite more than a doubling of construction activity, output per manhour increased but little. This was probably associated with the disturbances in the industry resulting from World War II and the reconversion period. The minor gains in productivity of this period were succeeded by a relatively rapid advance in the subperiod 1948–53, which has extended into more recent years.

If, as was suggested earlier, the productivity gains in the construction segment are understated by as much as one-third because of inadequate deflators, the true trend increase in output per manhour is closer to 1.3 per cent than to the 0.9 per cent indicated by Table E-I. But even with so major an upward adjustment, it is apparent that output per manhour in contract construction has increased significantly less, historically, than output per manhour in the private domestic economy as a whole.

APPENDIX E

TABLE E-I

Contract Construction: Output, Labor Inputs, and Productivity Ratios, Key Years, 1869–1953
(1929 = 100)

	Output	Persons Engaged[a]	Output per Person	Manhours[a]	Output per Manhour
1869	11.8	24.2	48.8	31.6	37.3
1879	18.4	27.0	68.1	34.8	52.9
1889	33.4	40.3	82.9	48.9	68.3
1899	43.5	55.0	79.1	66.0	65.9
1909	75.7	72.9	103.8	75.4	100.4
1919	56.3	63.4	88.8	62.1	90.7
1929	100.0	100.0	100.0	100.0	100.0
1937	61.4	75.5	81.3	63.7	96.4
1948	132.3	139.0	95.2	129.9	101.8
1953	174.1	155.4	112.0	143.2	121.6

[a] Absolute numbers of persons engaged and manhours are given in Tables A-VII and A-XI.